# RIPARIAN CORRIDOR RAPID ASSESSMENT METHOD

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# RIPARIAN CORRIDOR RAPID ASSESSMENT METHOD

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## TABLE OF CONTENTS

**Section** **Page**



<u>LIST OF FIGURES</u>

# 1.0 INTRODUCTION

The Chesapeake Bay Program's Federal Agencies' Chesapeake Ecosystem Unified Plan (FACUP) lists Federal commitments to accomplish the goals of the 1987 Chesapeake Bay Agreement. One commitment is to develop and adopt a stream assessment and inventory method for Federal lands. The Federal agencies need a riparian corridor assessment method that has a stream stability assessment component to increase the probability of success for riparian reforestation projects. Although numerous rapid riparian corridor assessment methods incorporate stream stability, only a few combine riparian and in-stream habitat assessment with stream stability assessment in an inventory and prioritization procedure.

The U.S. Fish and Wildlife Service – Chesapeake Bay Field Office (Service) has developed a comprehensive and rapid riparian corridor assessment method that includes quantitative stream stability assessment parameters. The primary objective of the assessment method is to identify and prioritize poor quality riparian corridor areas within a watershed for additional detailed assessment and/or restoration. The proposed method provides methodology for assessment of stream and riparian parameters that influence stream stability, nutrient uptake, and in-stream and riparian habitats.

# 2.0 METHOD DEVELOPMENT

## 2.1 Assessment Method Overview

The assessment method is a comprehensive riparian corridor assessment and inventory procedure which evaluates aspects of riparian and in-stream habitats and stream stability. Its intended use is to rapidly identify, assess, and prioritize stream corridor conditions within a watershed. It is a short-term decision making tool. Problem areas identified through the use of the method only represent current conditions and must be addressed within the immediate future (1 to 5 years). Beyond five years, the condition of problem areas will most likely be different.

The information gained from the assessment will provide the assessor with a sense of potential problems but not the extent of the problem. The method may not identify cause and effect relationships influenced by factors located outside of the assessment area. It focuses on identifying existing problems based on observation and not on a function, structure, and process analysis. A more detailed assessment is required to fully assess the functions, structure, and processes of the riparian corridor and to determine the effects of stream problems resulting from sources elsewhere in the watershed. A detailed assessment may also be required to refine the prioritization ranking of assessment areas that have similar ratings and when an understanding of the cause and effect relationship is needed to clearly identify the cause of problems.

Assessment conditions within different landscape and/or lithology characteristics cannot be compared against each other for priority ranking purposes. For example, a riparian corridor in a forested watershed would receive much different assessment scores than a riparian corridor in a predominately urban watershed. Or a riparian corridor in the Piedmont hydro-physiographic region could potentially receive different assessment scores than a riparian corridor in the Coastal Plain hydro-physiographic region.

The method, as with most rapid procedures, provides only a relative ranking rather than a quantitative evaluation of magnitudes of change. The prioritization of assessment areas is based solely on the objectives of this assessment methodology and assessment area scores. There are many other ranking factors used in prioritizing problem areas such as the likely rate of self-recovery, secondary impacts, relative importance of aquatic ecosystems being impacted, cost and feasibility of restoration, social effects, and site accessibility. The ranking factors used in the prioritization process should be determined by assessors and/or decision makers.

The method is intended for use by trained practitioners. Assessors must be knowledgeable in riparian ecosystem processes and well trained and experienced in identifying bankfull indicators. Additionally, assessors must have a basic understanding in watershed-based assessment procedures in order to correctly identify, assess, and prioritize stream corridor conditions.

## 2.2 Assessment Method Components

The assessment method has two main sections: 1) stream stability assessment and 2) riparian and in-stream habitat assessment. The stream stability section of the assessment method evaluates vertical and horizontal stability. Therefore, it is divided into two sections: 1) bank stability (horizontal) and 2) bed stability (vertical). The bank stability component of the assessment is based on a quantitative assessment method developed by David Rosgen (1996) and includes the following bank stability parameters:

- Bank height
- Root depth
- Root density
- Bank angle
- Surface protection

The bed stability component of the assessment is based primarily on existing assessment methods but includes a parameter to evaluate stream stability evolution trend. This assessment component includes the following bed stability parameters:

- Aggrading stream beds
- Degrading stream beds
- Stream stability evolutionary trend

The riparian and in-stream habitat assessment is a combination of existing stream and riparian habitat assessment methods with the inclusion of some additional parameters (EPA 1999, Baltimore County 1991, Pfankuch 1978, Chesapeake Bay Program 1995, and Johnson et al 1999). The riparian habitat assessment focuses on wildlife requirements, runoff reduction, and nutrient uptake potential. The in-stream assessment focuses on physical and chemical attributes of a stream. The riparian and in-stream habitat assessment contains the following parameters:

- In-stream cover
- Epifaunal cover
- Velocity/depth regimes
- Shading
- Water appearance
- Nutrient enrichment
- Riparian vegetation zone
- Riparian zone nutrient uptake potential

Each of these parameters was selected because they were considered key components in conducting an assessment on the overall health and condition of a riparian corridor. A balance between in-stream parameters and riparian parameters was attempted. Furthermore, a balance between the physical and chemical requirements of fisheries and macroinvertebrates was also attempted within the in-stream parameters. Lastly, a balance between structure and function requirements of terrestrial and aquatic wildlife was attempted within the riparian vegetation parameters.

### 2.3 Assessment Method Scoring

Each assessment parameter (e.g., in-stream cover) receives an individual rating. That individual rating is then subtotaled using the two main assessment sections (e.g., riparian and in-stream habitats and stream stability). Lastly, the subtotal assessment scores are tallied together to obtain an overall combined riparian corridor assessment score. Each assessment parameter score is used to determine the condition of the individual habitat parameter. The subtotal assessment scores are used to determine the conditions of the riparian and in-stream habitats and stream stability. The overall riparian corridor assessment score is used to determine the assessment area's general condition and to rank assessment areas relative to one another. In the event of tied scores, the riparian habitat and stream stability assessment scores and individual parameter scores can be used to prioritize potential restoration projects.

### 2.4 Assessment Method Testing

This method requires field-testing prior to general use. While the riparian and in-stream habitat section of the method is drawn primarily from a combination of existing methods, additional habitat parameters are included which may skew the riparian and in-stream habitat assessment score. Any given combination of habitat assessment parameters has the potential to either dominate the riparian and in-stream subtotal score or be dominated by other parameter combinations. For example, there may be too many or too few in-stream physical habitat assessment parameters versus in-stream chemical habitat attributes. Or there may be too many or too few riparian habitat assessment parameters versus in-stream habitat assessment parameters. This also applies to the stream stability section of the method. Furthermore, the stream stability subtotal score may dominate or be dominated by the riparian and in-stream subtotal score in the overall riparian corridor assessment score.

The scoring system also requires field-testing. Each assessment parameter has four potential ratings and each of these ratings has an associated numerical score (see Table 1 for example). The overall numerical range is 1 to 20 with each individual rating having a range of 5 numerals. For example, the numerical range for the Optimal rating is 20 to 16 and the numerical range for the Poor rating is 5 to 1. The range of numerical scores and their assignment to a specific rating may be too broad or not broad enough to accurately distinguish the differences in condition for a specific assessment parameter. Additionally, it may not be able to distinguish the relative differences in overall conditions between assessment areas. For example, a numerical range with a spread of three numerals may be sufficient to adequately assess the condition of an individual assessment parameter, but may not be appropriate in conducting a relative comparison between assessment areas (e.g., several ties in overall riparian assessment scores).

**TABLE 1- Example of Assessment Method Scoring**

| Stream Stability Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 6a. Aggrading Stream Beds (riffle/pool streams) (EPA 1999) | Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition | Some new increases in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools | Moderate deposition of new gravel, coarse sand on old and new bars: 35-50% of the bottom affected; sediment deposits at obstructions, and bends; moderate deposition of pools prevalent; width/depth ratio 12 - 40 | Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition; steep sloped riffles and depositional bars prevalent; width/depth ratio > 40 |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The procedure for field-testing of the method is not included in this report. However, it is the next step to take in order for the FACUP committee members to adopt and implement this method.

## 3.0 ASSESSMENT METHOD

This section of the report presents information on using the assessment method. There are three steps in the assessment: 1) in-office assessment, 2) field assessment, and 3) assessment area prioritization. This assessment method was developed for use by trained practitioners and the method procedures described here within are not a systematic procedural handbook. Assessors must be knowledgeable in riparian ecosystem processes and well trained and experienced in identifying bankfull indicators. Additionally, assessors must have a basic understanding in watershed-based assessment procedures in order to correctly identify, assess, and prioritize stream corridor conditions.

### 3.1 In-office Assessment

The purposes of the in-office assessment are to delineate the preliminary reach assessment areas, identify potential problem areas, and gain an initial understanding of potential riparian corridor conditions. All available existing information related to the project watershed should be collected. The minimum information required to delineate reach areas and identify potential problem areas include aerials photography (current and historic), stream system density, stream order, USGS topographic mapping, and drainage area at various locations throughout the watershed. USGS topography maps are easily obtained from USGS and there are several sources to obtain aerial photography such as USGS, NRCS, local conservation districts, state government, and internet sites. Stream density, stream order, and drainage areas can be obtained from USGS maps or any other scaled mapping showing stream networks. Any additional information such as GIS data layers (i.e., land cover and land use mapping and percentages), past assessment reports, soil mapping, NWI maps, FEMA maps, and interviews with resource agencies and local municipalities will further assist assessors in developing a general understanding of the project watershed.

The first step of the in-office assessment, once all existing data has been collected and reviewed, is to delineate the preliminary boundaries of the reach assessment areas. The delineation is based on the Rosgen Level I stream classification (a stream morphology classification system). The Rosgen Level I stream classification requires course measurements of stream slope, valley slope, sinuosity, channel shape (i.e., narrow-deep or wide-shallow) and meander-width ratio and Rosgen valley type classification from USGS topographic maps or some other type of scaled topographic maps. Refer to *Applied River Morphology*, Rosgen 1996 for details regarding Level I classification. Assessment areas should not exceed a maximum length of 2,000 feet. Actual reach assessment boundaries can be adjusted based on field collected data.

Potential problem areas are identified next, by reviewing the existing data. Aerial photography and/or GIS data are used in identifying areas lacking riparian vegetation, eroding streams, and adjacent land use activities that could impact the riparian corridor. Historic aerial photographs are used to identify potential trends in degradation or recovery. Land cover percentages, stream system density, and stream order are used to identify areas that could be potential sources of nutrients and areas which are sensitive to high nutrient levels and sensitive to land use changes. Past assessment reports, GIS data, and information obtained from interviews can further assist assessors in identifying potential problem areas.

The results of the in-office assessment are recorded onto worksheets or spreadsheets, keyed to a corresponding map showing each reach assessment area and potential problem areas. The data from the worksheet and map are used for two purposes during the field assessment. First, to ground-truth the in-office assessment results and second to provide the assessors with information to support their field assessments.

There are many other in-office analyses that can be performed such as gap analysis of vegetation corridors and natural areas, vegetation community typing, infrastructure analysis and future development, identification of potential heavy metal and pesticide point sources, soil analysis of potential wetland and percolation areas, and identification of threatened and endangered species. Assessors and/or decision makers will have to determine if there is sufficient time and available information to conduct additional in-office analyses.

## 3.2 Field Assessment

Once the in-office assessment has been completed, the field assessment can be conducted. The size and level of detail within the field method was developed to allow a field team of two people to assess 1 to 2 miles of stream reach per day. There are time-of-year and weather restrictions associated with the method. The best time of the year to use this method is during the warmer months and leaf-out period. While all of the assessment parameters can be evaluated any time of the year, there are certain assessment parameters that are better evaluated during these specific months of the year. The assessment parameters that apply to this include shading, water appearance, and nutrient enrichment.

Weather conditions also affect when the method can be used. Storm events cause poor visibility due to turbid water and affect a variety of assessment parameters such as bed stability, water appearance, nutrient enrichment, velocity flow regimes, in-stream cover, epifaunal substrate, and stream stability evolutionary trend. Cloudy conditions can also affect the shading assessment parameter.

The stream stability assessment section must be completed before the riparian and in-stream assessment section because stream stability influences which stream type an assessor uses in the latter section. For example, a pool/glide stream type with a sandy substrate may assess poorly in several assessment parameters if the assessor assesses the stream reach as a riffle/pool stream type because he/she thinks the stream is aggrading. If the assessor does the stability assessment section first, he/she will know whether the stream is or is not aggrading.

Each assessment parameter has four potential ratings: 1) Optimal, 2) Suboptimal, 3) Marginal, and 4) Poor. And each of these ratings has a numerical score associated with them. The total numerical score range is 1 to 20, with 20 as the best condition and 1 as the worst condition. The individual numerical score for each rating category is as follows:

- Optimal Rating - 20 to 16
- Suboptimal Rating - 15 to 11
- Marginal Rating - 10 to 6
- Poor Rating - 5 to 1

The assessor selects the most appropriate numerical score based on the rating description provided for each assessment parameter. A majority of the rating descriptions provide a clear description for the assessor to determine which numerical value to select within a given rating category. For example, a suboptimal rating, which has a range of 15 to 11, for in-stream cover is a 30% to 50% mixture of stable habitat. If the stable habitat is at least 50%, the assessor would select a numerical value of 20. If the stable habitat is at least 40%, the assessor would select a numerical value of 13. If the stable habitat is at least 30%, the assessor would select a numerical value of 11.

Once all of the individual assessment parameters have been evaluated, their scores are tallied within the two main sections of the method (stream stability and riparian and in-stream habitats). The two subtotals are then combined to obtain an overall riparian corridor assessment score. The overall riparian corridor assessment score uses the same four rating potentials but with different numerical scores:

- Optimal Rating – 320 to 248
- Suboptimal Rating - 247 to 175
- Marginal Rating - 174 to 102
- Poor Rating - 101 to 32

### 3.2.1 Stream Stability Assessment

#### *3.2.1.1 Bank Stability*

The bank stability assessment is based on a bank erosion potential method developed by David Rosgen (Rosgen, 1996). Rosgen states that the ability of streambanks to resist erosion is primarily determined by:

- The ratio of streambank height to bankfull stage
- The ratio of riparian vegetation rooting depth to streambank height
- The degree of rooting density
- The compositions of streambank materials
- Streambank angle
- Bank material stratigraphy and presence of soil lenses
- Bank surface protection afforded by debris and vegetation

Each one of these factors is included in this method. Figure 1 is a pictorial diagram that illustrates the different rating categories for each bank stability assessment parameter. The follow rating adjustments are to be made based upon bank materials and stratification:

*Bank Materials*

- All bank stability assessment parameters are rated as a 20 if the banks are bedrock.
- All bank stability assessment parameters are rated as a 16 if the banks are boulder dominated.
- If the cobble in a cobble/gravel/sand bank is >50%, the rating category for each bank stability assessment parameter increases by one. For example, if the bank height/bankfull height ratio has a suboptimal rating, the new rating should be optimal.
- If the gravel in a gravel/sand bank is <50%, the rating value for each bank stability assessment parameter decreases by one.

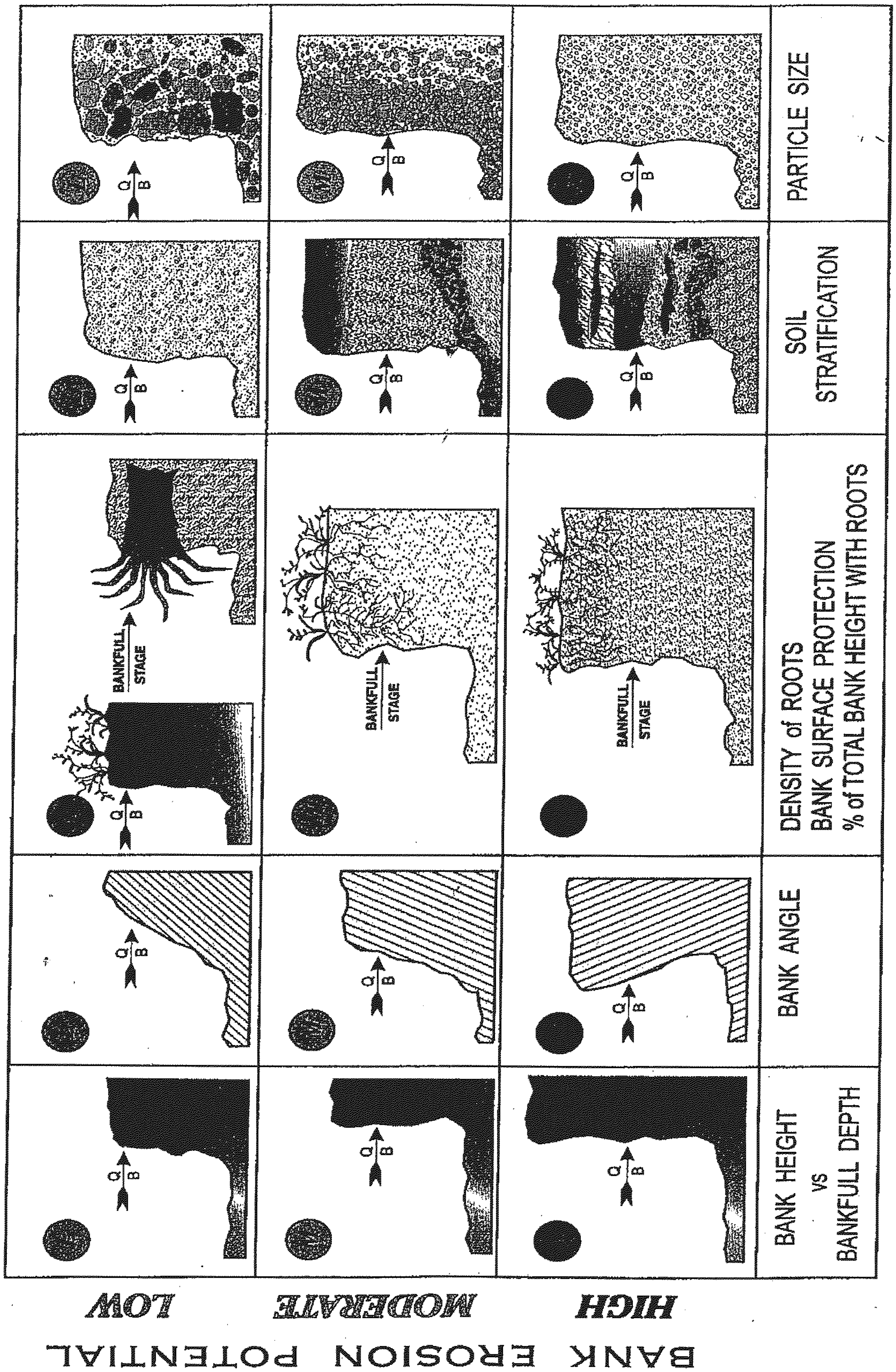


**FIGURE 1 – Stream Bank Erodibility Factors, after Rosgen, 1996**

*Stratification*

- If erodible materials, such as gravel, sand, or silt, represent >50% of the bank within the bankfull stage, the rating value for each bank stability assessment parameter decreases by one.

If bank conditions exist that would result in any rating adjustments, only one of the bank material adjustment criteria can be selected. However, the stratification criteria are added to any bank material downward adjustments. For example, if the bank height/bankfull height ratio has a suboptimal rating with a numerical value of 6 and the bank materials were 100% sand, the new category rating is marginal with a numerical value of 4. Under the bank materials criteria, the 100% sandbank resulted in a decrease of one rating category with a numerical value of 5. Under the stratification criteria, the location of 100% sand within the bankfull stage resulted in an additional decrease of one numerical value; thus a rating of 5 was reduced to 4.

If there is variability of bank conditions within an assessment area, separate bank stability ratings are completed for each bank. The final bank stability assessment score is a weighted average of all the banks assessed. For example, there are two very different types of bank conditions on the right bank of an assessment area that is 1,000 feet long. The first bank represents 30% of the assessment area and received an overall bank stability score of 30. The second bank represents 70% of the assessment area and received an overall bank stability score of 10. The assessment area would receive a final bank stability score of 16, using ((30*300 ft)+(10*700)/1000. There is an area on the bank stability field sheet were the individual bank stability ratings can be tallied and a weighted average can be calculated and recorded.

3.2.1.1.a Bank Height/Bankfull Height

| Stream Stability Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 1. Bank Height /Bankfull Height (Rosgen 1996) | Ratio of 1.0 -1.19 | | | Ratio of 1.2 -1.5 | | | Ratio of 1.6 - 2.0 | | | Ratio of > 2.1 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

The bank height/bankfull height ratio assessment parameter provides assessors with an indication of the type of flood events that remain within the channel and the erosion potential associated with those flows. Figure 2 illustrates how to measure banks and calculate the bank height/bankfull height ratio.

Bank Height/Bankfull Height Ratio:

$$\text{Ratio} = \frac{\text{Top of Bank Height}}{\text{Bankfull Height}} = \frac{8\text{ ft.}}{4\text{ ft.}} = 2$$

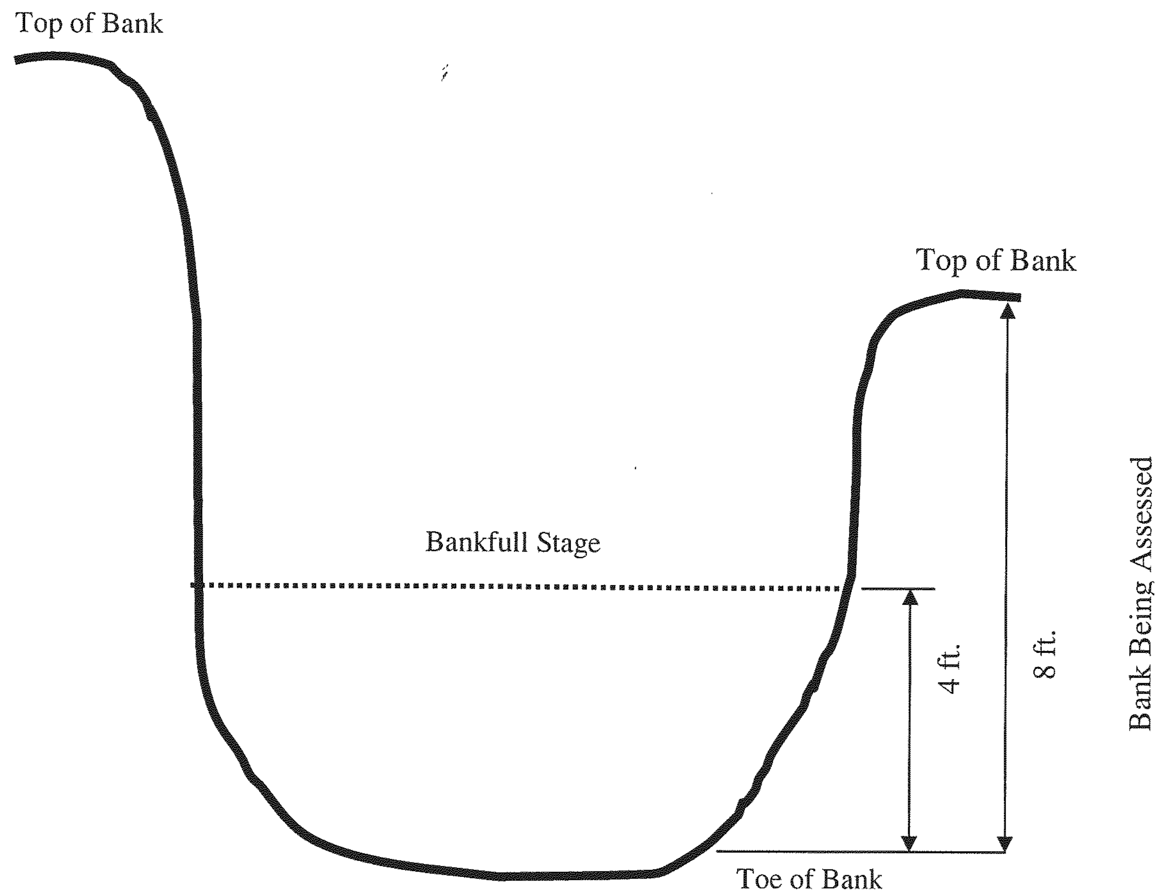


FIGURE 2 – Bank Height Ratio, after Rosgen, 1996

3.2.1.1.b Root Depth/Bank Height Ratio

| Stream Stability Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 2. Root Depth/Bank Height Ratio (Rosgen 1996) | Ratio of 0.5 – 1.0 | | | Ratio of 0.3 - 0.49 | | | Ratio of 0.15 - 0.29 | | | Ratio of < 0.14 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

The root depth/bank height ratio is calculated by dividing the root depth by the bank height. For example, if the root depth is 1 foot and the bank height is 4 feet, the root depth/bank height ratio is 0.25 and would have a marginal category rating.

3.2.1.1.c Root Density Percentage

| Stream Stability Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 3. Root Density % (Rosgen 1996) | 55% - 100% | | | 30% - 54% | | | 15% - 29% | | | <14% | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

Root density percentage is calculated first by estimating root density in only the rooted area. For example, a thick grass root mass would have a density approximately 90% even though the depth of the roots only represent 25% of the entire bank (root depth/bank height ratio). Then the root density is multiplied by the root depth/bank height ratio, calculated previously. The final calculated percentage is then used to rate the root density percentage. Using the root depth/bank height ratio example above and the grass root density example (0.9*0.25* 100%), the root density is 22.5% and has a marginal category rating.

3.2.1.1.d Bank Angle

| Stream Stability Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 4. Bank Angle (degrees) (Rosgen 1996) | 0 - 60 | | | 61 - 80 | | | 81 - 90 | | | >90 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

The location of the bank angle measurement is influenced by the degree of stress the angle exerts on the bank. For example, a severely cantilevered bank in the top one-third of the bank will have a greater influence on the bank stability than the lower vertical one-third of the bank. Therefore, degrees of bank angle are measured differently depending on the bank angle and profile. Figure 3 illustrates how bank angle is to be measured.

3.2.1.1.e Surface Protection

| Stream Stability Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 5. Surface Protection % (Rosgen 1996) | 55% - 100% | | | 30% - 54% | | | 15% - 29% | | | <14% | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

Surface protection percentage is determined by estimating the percentage of the bank protected from erosive flows. Protection, in the form of natural and/or man-made materials, may include vegetation, roots, boulders, cobbles, large woody debris, bedrock, riprap, sheetpile, and concrete. The estimate of protection is essentially based on the amount of bank that is not exposed bare soil.

### *3.2.1.2 Bed Stability*

Bed stability is one of the more difficult parameters to assess. Indicators of instability include large deposits of fine materials, embedded riffles, exposed utilities, severe entrenchment or incision, and poorly defined pools and riffles. To further complicate the assessment, some instability indicators may be from past disturbances and in actuality, the stream is recovering. This method has three bed stability assessment parameters. Two of the bed stability assessment parameters come from the EPA rapid bioassessment method and the third bed stability assessment parameter is based on the channel evolutionary cycle presented by Rosgen, 1996. The assessment parameters provide good descriptions of bed instability indicators, but assessment application requires well-trained and experienced personnel. Review of aerials (current and historical) and adjacent land uses can greatly assist in determining the stability of a stream. The aerials can show where stream reaches have been radically adjusting over time, more laterally than vertically. And, research has shown that certain types of land use activities severely impact stream stability.

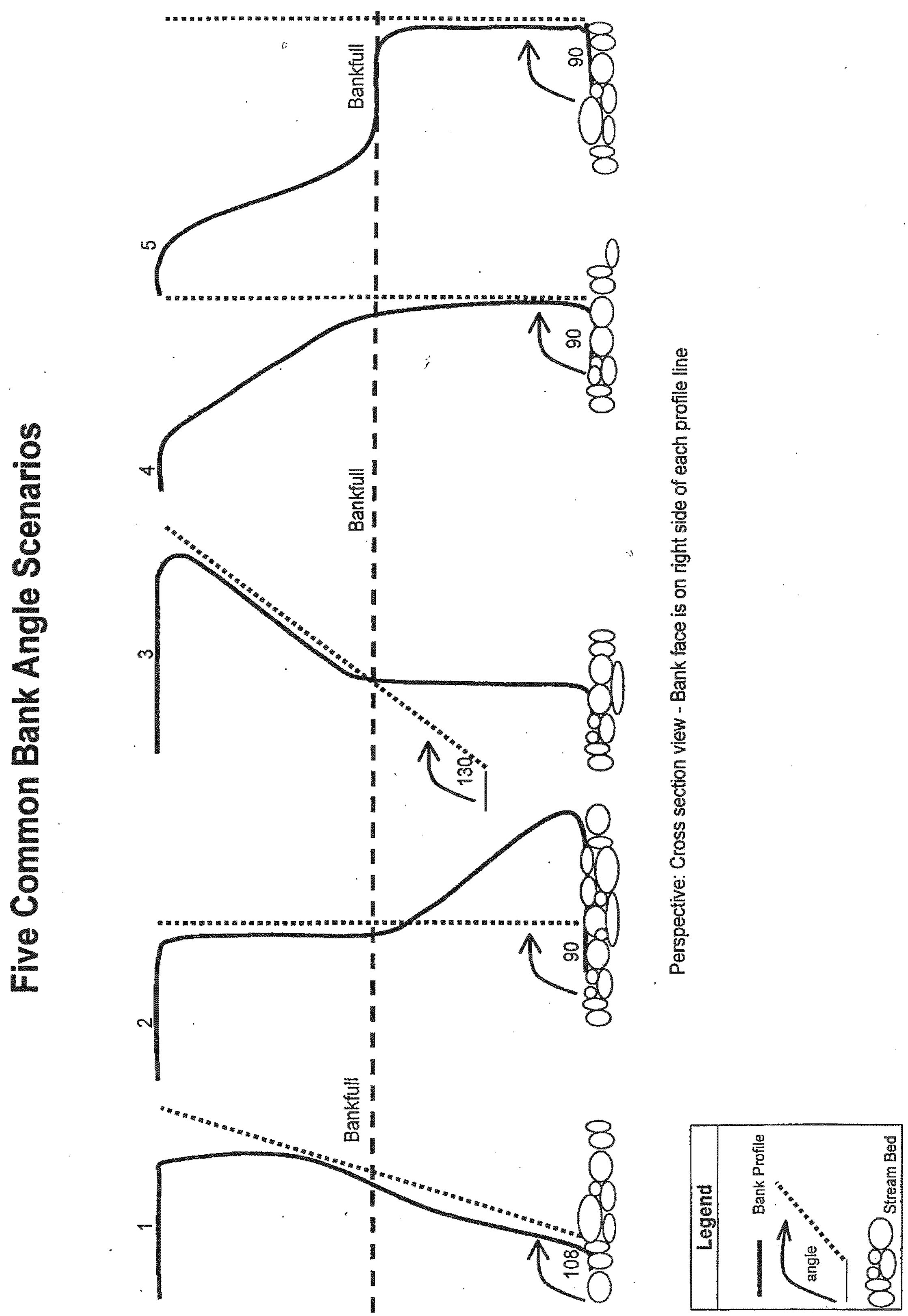


**FIGURE 3 – Bank Angles, after Rosgen, 2000**

### 3.2.1.2.a Aggrading Stream Bed

| Stream Stability Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 6a. Aggrading Stream Beds (riffle/pool streams) (EPA 1999) | Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition | Some new increases in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools | Moderate deposition of new gravel, coarse sand on old and new bars: 35-50% of the bottom affected; sediment deposits at obstructions, and bends; moderate deposition of pools prevalent; width/depth ratio 12 - 40 | Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition; steep sloped riffles and depositional bars prevalent; width/depth ratio > 40 |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6b. Aggrading Stream Beds (pool/glide streams) (EPA 1999) | Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars | 20-50% affected; moderate accumulation; substantial sediment movement only during storm event; some new increase on bar formation | 50-80% affected; major deposition; pools shallow, heavily silted; berms may be present on both banks; frequent and substantial sediment movement during storm events; width/depth ratio 12 – 40 | > 80% affected; braided channels; depositional bars actively forming and unstable; pools almost absent due to deposition; width/depth ratio > 40 |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The aggrading streambed assessment parameter evaluates whether a stream has sufficient power to transport its sediment load. There are two different assessment descriptions; one for riffle/pool streams and one for pool/glide streams. It is important to select the correct assessment description because a riffle/pool stream that is severely aggrading could appear to be a pool/glide stream. Pool/glide streams are typically very shallow sloped whereas riffle/pool streams are moderately to steeply sloped. The criteria listed in the next paragraph can also be used to help distinguish whether a stream is a pool/glide stream or is an aggrading riffle/pool stream.

A width/depth ratio criterion has also been added to the assessment descriptions. Aggrading streams typically have a high width/depth ratio of 40 or greater. Other indicators of an aggrading stream may include braided channels, multiple bar development, bars steeply sloped on downstream end, soft channel bottoms, poorly defined pools, riffles, and glides, channel bottom adjustment with every storm event, channel bottom close to the top of the bank, and excessive sand deposits on the flood plain.

### 3.2.1.2.b Degrading Stream Bed

| Stream Stability Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 7. Degrading Stream Beds (EPA, 1999 & Rosgen, 1996) | < 5% of bottom affected by localized vertical channel down-cutting | 5-30% of bottom affected by localized vertical channel down-cutting or scouring | 35-50% of bottom affected by widespread vertical down-cutting; headcuts may be present; incision ratio 1.6 – 2.0; riffles and pools poorly defined; some toe-of-bank erosion | > 50% of bottom affected by widespread vertical down-cutting; headcuts may be present; active toe-of-bank erosion; incision ratio > 2.1; riffles and pools lacking; subpavement or parent material exposed; entrenchment < 1.4; floodplain abandoned |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The degrading streambed assessment parameter evaluates whether the stream has increased its stream power and the ability to transport more than its typical sediment load. Degrading streams are somewhat easier to assess than aggrading streams. They typically have high incision ratios (>2.0), low entrenchment ratios (<1.4), low to moderate width/depth ratios (<12), head cuts, lacking pools and riffles, subpavement or parent material exposed, channel straightening, and gully-shaped channels. However, just as with an aggrading stream, a degrading stream may be recovering and degradation indicators could be from past adjustments.

### 3.2.1.2.c Stream Stability Evolutionary Trend

| Stream Stability Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 8. Stream Stability Evolutionary Trend (Rosgen, 1996) | Little or no presence of active vertical or lateral stream adjustment; floodplain well-developed, vegetated and hydrologically connected to stream | Presence of localized vertical or lateral stream adjustment; floodplain well-developed, vegetated and hydrologically connected to stream (floodplain can be newly formed within a channel that shows past active vertical or lateral channel adjustments) | Channel shows past evidence of active vertical down-cutting and lateral widening but is currently rebuilding a new floodplain; presence of moderately defined riffles and pools; moderate aggradation occurring; width/depth ratio 12-40 | Channel has widespread active vertical down-cutting and lateral widening; floodplain not hydrologically connected (abandoned floodplain); lack of well defined riffles and pools; incision ratio > 2.1; sinuosity ratio < 1.2; entrenchment < 1.4 |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The stream evolutionary trend criteria are useful in prioritizing areas for restoration or protection. If a stream is unstable but is on a trend to recovery, it should receive a lower priority than an unstable stream that is on a trend to further degradation. Figure 4 illustrates several examples of evolutionary cycles. An assessor needs to be knowledgeable of the Rosgen classification system in order to understand the evolutionary cycles presented in Figure 4. A degrading stream generally starts to downcut and then widens. An aggrading stream may indicate that a stream is recovering from past degradation. However, a stable stream that becomes unstable from aggradation, is usually a result of either increased sediment supply, reduction of stream flow (typically from damming or water diversion), or flow blockages. Aerial photography review (current and historical) can assist in determining where an unstable stream might be in the evolutionary cycle. This is done by conducting a trend analysis of past stream adjustments.

### 3.2.2 Riparian and In-stream Habitat Assessment Parameters

All but two of the assessment parameters contained within the riparian and in-stream habitat assessment section are either from the EPA rapid bioassessment method (EPA, 1999) or the NRCS stream visual assessment method (NRCS, 1999). Therefore, the descriptions of these assessment parameters will be brief. For a detailed explanation of parameters, refer to the EPA and NRCS method descriptions.

#### *3.2.2.1 In-stream Cover*

| Habitat Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 1a. In-stream Cover (riffle/pool streams) (EPA 1999) | Greater than 50% mix of boulder, cobble, submerged logs, or other stable habitat | 30 - 50% mix of boulder, cobble, or other stable habitat; adequate habitat | 10 - 30% mix of boulder, cobble, or other stable habitat; habitat available less than desirable | Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 1b. In-stream Cover (pool/glide streams) (EPA 1999) | Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; gravel may be present | 30 - 50% mix of stable habitat; adequate habitat for maintenance of populations | 10 – 30% mix of stable habitat; habitat available less than desirable | Less than 10% stable habitat; lack of habitat is obvious |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The in-stream cover assessment parameter evaluates the amount and availability of physical habitat for fish. There are two types of in-stream cover assessment parameters; for streams dominated by a riffle/pool sequence and for streams dominated by a pool/glide sequence. The in-stream cover assessment parameter that best represents the stream type within the assessment area will be used. In pool/glide stream types, the

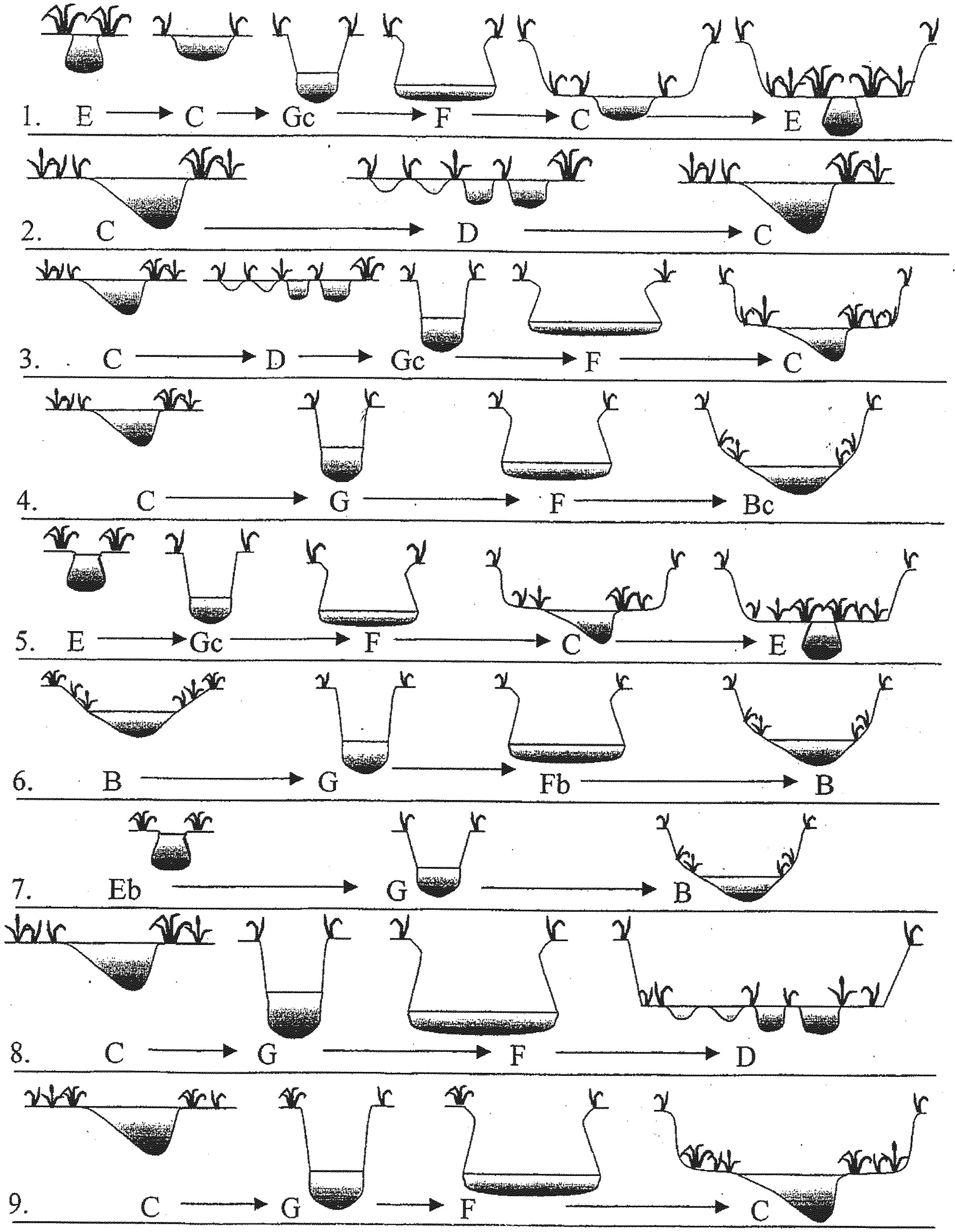


**FIGURE 4 – Evolutionary Stream Cycles, after Rosgen, 2000**

results of the aggrading bed stability assessment parameter is used to determine whether the stream type is a pool/glide stream type or actually an aggrading riffle/pool stream type. Typical in-stream cover habitat may include large woody debris, submerged logs, deep pools, undercut banks, boulder and cobbles, overhanging vegetation, riffle areas, and thick root mats.

### *3.2.2.2 Epifaunal Substrate*

| Habitat Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 2a. Epifaunal Substrate (riffle/pool streams) (EPA 1999) | Well-developed riffles and pools, riffle is as wide as stream and extends two times the width of the stream; abundance of cobble | Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common | Run area may be lacking; riffle not as wide as stream and length is less than two times width; gravel, boulders, clay or sand prevalent; some cobble present | Riffle or runs virtually non-existent; boulders, clay or sand prevalent; some cobble lacking |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 2b. Epifaunal Substrate (pool/glide streams) (EPA 1999) | Preferred benthic substrate abundant (snags, logs, gravel with firm sand, root mats, and submerged vegetation) | Substrate common but not prevalent (mixture of soft sand, mud or clay; some root mats and submerged vegetation) | Substrate frequently disturbed or removed (all mud or clay bottom; little or no root mats; no submerged vegetation) | Substrate unstable or lacking (hardpan clay; no root mats or submerged vegetation) |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The epifaunal substrate assessment parameter evaluates the amount and availability of physical habitat for aquatic insects and invertebrates. This assessment parameter also has two types of assessment parameters: 1) streams dominated by a riffle/pool sequence and 2) streams dominated by a pool/glide sequence. Again, for pool/glide stream types, the results of the aggrading bed stability assessment parameter is used to determine whether the stream type is a pool/glide stream type or actually an aggrading riffle/pool stream type. Typical aquatic insect and invertebrate habitat may include large woody debris, submerged logs, overhanging vegetation, riffle areas, and thick root mats.

### *3.2.2.3 Velocity/Depth Regimes*

| Habitat Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 3a. Velocity/Depth Regimes (riffle/pool streams) (EPA 1999) | All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes) | Only 2 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes) | Dominated by 1 flow regime (usually slow-deep or slow-shallow) |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 3b. Pool Variability (pool/glide streams) (EPA 1999) | Even mix of large-shallow, large-deep, small-shallow, and small-deep pools present | Majority of pools large-deep; very few shallow | Shallow pools much more prevalent than deep pools | Majority of pools small-shallow or pool absent |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The velocity/depth regimes and pool variability assessment parameters evaluate the variability of stream velocities and depths. The importance of variability in velocities and depths is directly related to aquatic species composition diversity. Different species require different velocities and depths to survive and propagate.

The variability in depths and velocities are relative to the assessment area. A small first order stream will obviously have very different depths and velocities than a third or fourth order stream. Note that depths will vary more greatly than velocities between order of streams.

There are four distinct flow regimes for riffle/pool dominated streams: slow-deep, slow-shallow, fast-deep, and fast-shallow. Slow flowing, deep waters are typically associated with pools. Slow flowing, shallow waters are typically associated with glides or the tail-out of a pool. Fast flowing, deep waters are typically associated with runs or the tail-out of a riffle. Fast flowing, shallow waters are typically associated with riffles.

There are four distinct flow regimes for pool/glide dominated streams: large-shallow, large-deep, small-shallow, and small-deep pools. Large- and small-shallow waters are typically associated with glides and runs. Large- and small-deep waters are typically associated with pools. Large versus small pools refer to the length of the pool.

#### *3.2.2.4 Shading*

| Habitat Parameter | Category | | | |
|---|---|---|---|---|
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| 4a. Shading (coldwater fishery) (USDA 1999) | >75% of water surface shaded and upstream 2 to 3 miles generally well shaded | >75% of water surface shaded or >50% of reach shaded, but upstream 2 to 3 miles poorly shaded | 20 - 50% of stream surface shaded | <20% of water surface shaded |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 4b. Shading (warmwater fishery) (EPA 1999) | 25-90% of the water surface covered; a mixture of conditions; areas fully shaded, fully open, and degrees of filter light | >90% of water surface covered, full canopy cover; entire water surface receives filtered light or no light | No scoring in this category | <25% of water surface shaded; lack of a canopy; full sunlight reaches water surface |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The shading assessment parameter evaluates the degree to which a stream is shaded by vegetation. Overhanging vegetation includes shrubs, understory, and canopy vegetation. For the shade assessment, the shaded areas are divided into three types of shading: 1) no shade, 2) poor shade, and 3) good shade. The NRCS 1999 Stream Visual Assessment Methods use the following criteria to assist assessors in measuring shade:

- Stream surface not visible: >90%
- Surface slightly visible or only in patches: 70% – 90%
- Surface visible, but banks not visible: 40% - 70%
- Surface visible and banks visible at times: 20% - 40%
- Surface and banks visible: <20%

(Note: Visibility of stream surface and stream banks are based on an aerial perspective.)

The rating of shaded areas has different percentages depending upon whether the stream is a cold or warm water stream. State natural resource agencies typically have maps and/or reports which indicate whether a stream is a cold or warm water stream. Evaluations of shade require time of year, time of day, and weather condition considerations. For best assessment results, the shading assessment should be evaluated during leaf-out periods and in the middle of sunny days. If the stream type is a natural meadow stream, meaning a stream that naturally has only herbaceous riparian vegetation, then the shading score is either optimal or suboptimal, depending on the health of the herbaceous vegetation. If the herbaceous vegetation is robust and dense, then the shading score is optimal. If it is struggling and sparse, then the shading score is suboptimal.

### 3.2.2.5 Water Appearance

| Habitat Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 5. Water Appearance (USDA 1999) | Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks | Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 ft; may have slight green color; no oil sheen on water surface | Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with green or olive-green film; or moderate odor of ammonia or rotten eggs | Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The water appearance assessment parameter evaluates water turbidity and potential pollutants. Turbidity is evaluated after the stream has had time to settle following a storm event. Streams that contain pollutants will have any one of the following indicators; surface scum, oily sheen, strong odors from sewage and chemicals, substrate covered with orange material which comes can from acid inputs, and greenish color from excessive nutrient inputs. Note that orange material in the stream can be naturally occurring as a result of iron decomposition.

### 3.2.2.6 Nutrient Enrichment

| Habitat Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 6. Nutrient Enrichment (USDA 1999) | Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present | Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrate | Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months | Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

The type and amount of aquatic vegetation in a stream typically represents the level of nutrient loads in a stream. The greater the amount of algae and macrophytes within a stream generally indicates the severity of excessive nutrients. Additionally as nutrient levels rise, the greenish color of the water becomes more intense. Alga production and aquatic vegetation growth decreases during the cooler times of the year. High order streams open to the sun often have murkier water when sunlight allows greater algae growth.

### *3.2.2.8 Riparian Vegetation Zone*

| Habitat Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 7. Riparian Vegetation Zone (EPA 1999) | Riparian zone extends to a width of > 100 feet; all three layers of vegetation exists; good vegetation community diversity and density; human activities do not impact zone | | | Riparian zone extends to a width of 60 – 100 feet; one layer of vegetation not well represented; fair vegetation community diversity and density; human activities minimally impact zone | | | Riparian zone extends to a width of 30 - 60 feet; two layers of vegetation not well represented; species composition is dominated by 2 or 3 species; human activities greatly impact zone | | | Riparian zone extends to a width of <30 feet; little or no riparian vegetation due to human activities | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

The riparian vegetation zone assessment parameter evaluates riparian habitat conditions for wildlife and the ability of the vegetation to buffer impacts from adjacent land use activities. The riparian vegetation zone is the width of natural vegetation from the edge of the active channel out onto the floodplain. A healthy riparian vegetation zone contains diverse and dense plant communities (at all vegetation layers) and a variety of habitat conditions and food sources for terrestrial and aquatic species.

The left and right banks are first assessed separately just as in the bank vegetation assessment parameter. Vegetation width and diversity are the two key criteria for this assessment. A riparian zone can only receive an optimal rating if it is greater than 100 feet wide and all three layers of vegetation exist. A riparian zone can not receive an optimal even if it is greater than 100 feet wide, but does not contain all three layers of vegetation. Likewise, a riparian zone can not receive an optimal rating even if all three layers of vegetation exists, but is not greater than 100 feet wide.

### *3.2.2.9 Riparian Zone Nutrient Uptake Potential*

| Habitat Parameter | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimal | | | Suboptimal | | | Marginal | | | Poor | |
| 8. Riparian Zone Nutrient Uptake Potential (Chesapeake Bay Program, 1995, EPA, 1999 & Baltimore County, 1991) | All three zones of vegetation exist; runoff is primarly sheet flow; hillslopes < 10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented | | | One zone of vegetation not well represented (Zone 2 must be well represented); runoff is mostly sheet flow with minor concentrated flow; hillslopes 10 - 20%; hillslopes 100 - 200 ft from stream; ponding or wetland areas and litter or debris jams are moderately represented | | | Only Zone 2 of vegetation is well represented; runoff is equally sheet and concentrated flow (moderate gully and rill erosion); hillslopes 20 - 40%; hillslopes 50 - 100 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented | | | No zones of vegetation well represented; runoff is primarily concentrated flow (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or completely absent | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

The riparian zone nutrient uptake potential assessment parameter evaluates the potential of the riparian zone to buffer the introduction of sediment and nutrients into a stream system. There are three zones of vegetation: Zone 1 undisturbed forest, Zone 2 managed forested, and Zone 3 grass (Chesapeake Bay Program, August 1995). Zone 1 is primarily woody vegetation directly adjacent to the stream. Its primary functions are to provide streambank stability and favorable habitat for aquatic species. Zone 2 is also primarily woody vegetation and adjacent to Zone 1. Its primary function is to remove, sequester, or transform nutrients, sediment, and other pollutants. Zone 3 is adjacent to Zone 2 and is furthest from the stream channel. It is primarily herbaceous vegetation and functions to remove sediment and sediment associated chemicals and to spread surface runoff entering as concentrated flow into Zone 2.

Left and right riparian zones should be assessed separately, then combined for a total score. There are many components within the riparian zone that affect nutrient uptake and filtering of sediments. However, surface runoff type, zones of vegetation, and point source pollution are the three key criteria for this assessment. The other criteria listed for this assessment parameter are used to assist the assessor in selecting the numerical value within a rating category. A riparian zone can only receive an optimal rating if it has all three riparian zones and has primarily sheet flow runoff.

## 3.3 Assessment Area Prioritization

The assessment area prioritization is based on the primary restoration objective of restoring riparian vegetation in areas with stable streams. This restoration objective, as stated in the introduction, was the impetus behind the development of this assessment method. Therefore, the following are the criteria used for prioritizing assessment areas:

1) restore areas with degraded riparian vegetation and stable streams; 2) restore unstable streams where there is healthy riparian vegetation to prevent any loss of vegetation from severe stream adjustments; and 3) restore areas with degraded riparian vegetation and unstable streams.

This prioritization is just an initial screening of the assessment areas based on these objectives and assessment scores only. It does not take into account any other multitude of prioritization factors like different objectives, site opportunities and constraints, cost and feasibility of restoration, stratification of assessment scores by Rosgen stream type, site access, future development, or additional data from a more detailed study. The inclusion of any one of these other factors could change the prioritization of the assessment areas. The assessors and/or decision makers who use this assessment method will have to determine whether other factors should weigh in on the prioritization of assessment areas. In most cases, assessors will have to revisit the high priority assessment areas to determine cause and effect relationships and to make more informed prioritization decisions.

The following is an example of the criteria used to prioritize assessment areas based on the above restoration objectives:

- First, review only the stream stability scores and identify all assessment areas with stable streams.
- Second, review all the assessment areas with stable streams and identify and rank the areas based on the riparian and in-stream assessment score. The ones with the lowest scores are the highest priority for restoration.
- Third, review only the riparian and in-stream assessment scores and identify assessment areas with healthy riparian vegetation.
- Fourth, review all the assessment areas with healthy riparian vegetation and identify and rank the areas based on the stream stability assessment score. The ones with the lowest scores are the next priority for restoration.
- Finally, combine and rank the riparian and in-stream and stream stability assessment scores of the remaining assessment areas. The lowest scores are the next priority areas.

## 4.0 SUMMARY

The stream and riparian habitat assessment method provides methodology for trained practitioners to a rapidly assess and inventory stream and riparian parameters that influence stream stability, nutrient uptake, and in-stream and riparian habitats. The information gained from the assessment will provide the assessor with a sense of potential problems but not the extent of the problem. A more detailed assessment is required to fully assess the functions and structure of the riparian corridor and to determine the effects of stream problems resulting from sources elsewhere in the watershed.

The method has two main assessment sections: 1) stream stability assessment and 2) riparian and in-stream habitat assessment. The stream stability section evaluates bank stability and bed stability. The bank stability component of the assessment is based on a quantitative assessment method developed by David Rosgen (1996). The bed stability component of the assessment is based primarily on existing assessment methods but includes a stability evolution trend parameter.

The riparian and in-stream habitat assessment is primarily a combination of existing stream and riparian habitat assessment methods with the inclusion of some additional assessment parameters. The riparian habitat assessment focuses on wildlife requirements, runoff reduction, and nutrient uptake potential. The in-stream assessment focuses on physical and chemical attributes of a stream.

The method requires both in-office and field assessments. The in-office assessment is used to gain an initial understanding of potential riparian corridor and stream conditions and to delineate the preliminary reach assessment area boundaries based on available existing information. The field assessment is used to determine the existing physical condition of the riparian corridor based on the completion of the field data assessment forms. The field assessment, as with most rapid assessments, only provides a relative ranking rather than a quantitative evaluation of magnitudes of change. Each assessment parameter has four potential ratings: 1) Optimal, 2) Suboptimal, 3) Marginal, and 4) Poor. And each of these ratings has a numerical score, ranging from 1 to 20 with 20 as the best condition, associated with them. The assessor selects the most appropriate numerical score based on the rating description provided for each assessment parameter.

Once all of the individual assessment parameters have been evaluated, their scores are tallied within the two main sections of the method (stream stability and riparian and in-stream habitats). The two subtotals are then combined to obtain an overall riparian corridor assessment score. The overall riparian corridor assessment score uses the same four rating potentials (optimal, suboptimal, marginal, and poor) with a numerical range of 320 to 32 with 320 as the best condition.

The identification and prioritization of problem areas can be accomplished several different ways, all dependent upon restoration objectives. This report provides an example in Section 3.3 Assessment Area Prioritization, of problem area prioritization based only on a primary restoration objective of restoring riparian vegetation where streams are stable. In this example, the stream stability assessment subtotals were used to identify stable stream reaches. The riparian and in-stream habitat assessment subtotal scores were then used to screen the stable stream reaches that had poor riparian vegetation.

This method requires field-testing before general application. While the riparian and in-stream habitat section of the method is primarily a combination of existing methods, this method includes additional habitat parameters that may skew the riparian and in-stream habitat assessment score. Any given combination of habitat assessment parameters has the potential to either dominate the subtotal score or be dominated by other parameter combinations. This also applies to the stream stability section of the method. The bank stability assessment parameters may dominate or be dominated by the bed stability assessment parameters. Furthermore, the stream stability subtotal score may dominate or be dominated by the riparian and in-stream subtotal score in the overall riparian corridor assessment score.

The scoring system also requires field-testing. Each rating category has an associated numerical score. The overall numerical range is 1 to 20 with each individual rating having a range of 5 numerals. For example, the numerical range for the Optimal rating is 11 to 20 and the numerical range for the Poor rating is 1 to 5. The range of numerical scores and their assignment to a specific rating may be too broad or not broad enough to accurately distinguish the differences in condition for a specific assessment parameter. Additionally, it may not be able to distinguish the relative differences in overall conditions between assessment areas. For example, a numerical range with a spread of three numerals may be sufficient to adequately assess the condition of an individual assessment parameter, but may not be appropriate in conducting a relative comparison between assessment areas (e.g., several ties in overall riparian assessment scores).

This assessment method is intended to rapidly identify, assess, and prioritize existing stream corridor conditions within a watershed. The key word is rapid. There are many other procedures to collect and perform in-depth data analyses and problem area prioritization. This is a short-term decision making tool. Problem areas identified through the use of this method only represent current conditions and must be addressed within the immediate future (1 to 5 years). Beyond five years, the condition of problem areas will most likely be different. Assessors and/or decision makers who use this assessment method will have to determine whether other analyses should be performed to meet their objectives in identifying, assessing, and prioritizing riparian corridor problem areas.

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# APPENDIX A

# FIELD DATA SHEETS

# RIPARIAN CORRIDOR ASSESSMENT FIELD DATA SHEET



Watershed: ______________________

Stream: ______________________

Reach ID: ______________________

Riparian/Instream Habitat Score: __________

Total Riparian Corridor Score: __________

Notes: ______________________

Rater(s): ______________________

Date: ______________________

Stream Stability Score: __________

Weather Condition: __________

## STREAM STABILITY ASSESSMENT

| Stream Stability Parameter | | Category | | | |
|---|---|---|---|---|---|
| | | Optimal | Suboptimal | Marginal | Poor |
| **Bank Stability** | | | | | |
| 1. Bank Height /Bankfull Height (Rosgen 1996) | | Ratio of 1.0 -1.19 | Ratio of 1.2 -1.5 | Ratio of 1.6 - 2.0 | Ratio of > 2.1 |
| | left: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| 2. Root Depth/Bank Height Ratio (Rosgen 1996) | | Ratio of 1.0 - 0.50 | Ratio of 0.49 - 0.3 | Ratio of 0.29 - 0.15 | Ratio of < 0.14 |
| | left: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| 3. Root Density % (Rosgen 1996) | | 100% - 55% | 54% - 30% | 29% - 15% | <14% |
| | left: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| 4. Bank Angle (degrees) (Rosgen 1996) | | 0 - 60 | 61 - 80 | 81 - 90 | >90 |
| | left: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| 5. Surface Protection % (Rosgen 1996) | | 100% - 55% | 54% - 30% | 29% - 15% | <14% |
| | left: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: | 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| | | Total Bank Score ______ | | | |
| | | Wieghted Bank Score ______* | | | |
| **Bed Stability** | | | | | |
| 6a. Aggrading Stream Beds (riffle/pool streams) (EPA 1999) | | Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition | Some new increases in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools | Moderate deposition of new gravel, coarse sand on old and new bars: 35-50% of the bottom affected; sediment deposits at obstructions, and bends; moderate deposition of pools prevalent; width/depth ratio 12 - 40 | Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition; steep sloped riffles and depositional bars prevalent; width/depth ratio > 40 |
| SCORE ______ | | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6b. Aggrading Stream Beds (pool/glide streams) (EPA 1999) | | Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars | 20-50% affected; moderate accumulation; substantial sediment movement only during storm event; some new increase on bar formation | 50-80% affected; major deposition; pools shallow, heavily silted; berms may be present on both banks; frequent and substantial sediment movement during storm events; width/depth ratio 12 - 40 | > 80% affected; braided channels; depositional bars actively forming and unstable; pools almost absent due to deposition; width/depth ratio > 40 |
| SCORE ______ | | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

# STREAM STABILITY ASSESSMENT

| Stream Stability Parameter | Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 7. Degrading Stream Beds (EPA 1999 & Rosgen, 1996) | < 5% of bottom affected by localized vertical stream channel down-cutting | 5-30% of bottom affected by localized vertical stream channel down-cutting or scouring | 35-50% of bottom affected by widespread vertical down-cutting; head cuts may be present; incision ratio 1.6 - 2.0; riffles and pools poorly defined; some toe-of-bank erosion | > 50% of bottom affected by widespread vertical down-cutting; head cuts may be present; active toe-of-bank erosion; incision ratio > 2.1; riffles and pools lacking; subpavement or parent material exposed; entrenchment < 1.4; floodplain abandoned |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Stream Stability Evolutionary Trend (Rosgen, 1996) | Little or no presence of active vertical or lateral stream adjustment; floodplain well developed, vegetated and hydrologically connected to stream | Presence of localized vertical or lateral stream adjustment; floodplain well developed, vegetated and hydrologically connected to stream (floodplain can be newly formed within a channel that shows past active vertical or lateral stream adjustments) | Channel shows past evidence of active vertical downcutting and lateral widening but is currently rebuilding a new floodplain; presence of moderately defined riffles and pools; moderate aggradation occurring; width/depth ratio 12-40 | Channel has widespread active vertical downcutting and lateral widening; floodplain not hydrologically connected (abandoned floodplain); lack of well defined riffles and pools; incision ratio > 2.1; sinuosity ratio < 1.2; entrenchment < 1.4 |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| **Stream Stability Total Score** __________ | | | | |

* Wieghted bank score is only used if there is more than one bank type condition existing within the assessment area.

Watershed: ________________________________

Sheet 2 of 4

Stream: ________________________________

Rater(s): ______________________

Reach ID: ________________________________

Date: ______________________

Notes: ________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

# RIPARIAN CORRIDOR ASSESSMENT FIELD DATA SHEET



Watershed: ______________________________

Stream: ______________________________ Rater(s): ______________________

Reach ID: ______________________________ Date: ______________________

Notes: ____________________________________________________________

____________________________________________________________

| RIPARIAN/INSTREAM HABITAT ASSESSMENT | | | | |
|---|---|---|---|---|
| Habitat Parameter | Category | | | |
| | Optimal | Suboptimal | Marginal | Poor |
| 1a. Instream Cover (riffle/pool streams) (EPA 1999) | Greater than 50% mix of boulder, cobble, submerged logs, or other stable habitat | 30-50% mix of boulder, cobble, or other stable habitat; adequate habitat | 10-30% mix of boulder, cobble, or other stable habitat; habitat available less than desirable | Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 1b. Instream Cover (pool/glide streams) (EPA 1999) | Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; gravel may be present | 30- 50% mix of stable habitat; adequate habitat for maintenance of populations | 10-30% mix of stable habitat; habitat available less than desirable | Less than 10% stable habitat; lack of habitat is obvious |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 2a. Epifaunal Substrate (riffle/pool streams) (EPA 1999) | Well-developed riffles and pools, riffle is as wide as stream and extends two times the width of the stream; abundance of cobble | Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common | Run area may be lacking; riffle not as wide as stream and length is less than two times width; gravel, boulders, clay or sand prevalent; some cobble present | Riffle or runs virtually non-existent; boulders, clay or sand prevalent; some cobble lacking |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 2b. Epifaunal Substrate (pool/glide streams) (EPA 1999) | Preferred benthic substrate abundant (snags, logs, gravel with firm sand, root mats, and submerged vegetation | Substrate common but not prevalent (mixture of soft sand, mud or clay; some root mats and submerged vegetation) | Substrate frequently disturbed or removed (all mud or clay bottom; little or no root mats; no submerged vegetation) | Substrate unstable or lacking ( hardpan clay; no root mats or submerged vegetation) |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 3a. Velocity/Depth Regimes (riffle/pool streams) (EPA 1999) | All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes) | Only 2 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes) | Dominated by 1 flow regime (usually slow-deep or slow-shallow) |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 3b. Pool Variability (pool/glide streams) (EPA 1999) | Even mix of large- shallow, large-deep, small-shallow, and small-deep pools present | Majority of pools large-deep; very few shallow | Shallow pools much more prevalent than deep pools | Majority of pools small-shallow or pool absent |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 4a. Shading (coldwater fishery) (USDA 1999) | >75% of water surface shaded and upstream 2 to 3 miles generally well shaded | >75% of water surface shaded or >50% of reach shaded, but upstream 2 to 3 miles poorly shaded | 20 - 50% of stream surface shaded | <20% of water surface shaded |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 4b. Shading (warmwater fishery) (EPA 1999) | 25-90% of the water surface covered; a mixture of conditions; areas fully shaded, fully open, and degrees of filter light | >90% of water surface covered, full canopy cover; entire water surface receives filtered light or no light | No scoring in this category | <25% of water surface shaded; lack of a canopy; full sunlight reaches water surface |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |

## RIPARIAN/INSTREAM HABITAT ASSESSMENT

| Habitat Parameter | Category: Optimal | Category: Suboptimal | Category: Marginal | Category: Poor |
|---|---|---|---|---|
| 5. Water Appearance (USDA 1999) | Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks | Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 ft; may have slight green color; no oil sheen on water surface | Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with green or olive-green film; or moderate odor of ammonia or rotten eggs | Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Nutrient Enrichment (USDA 1999) | Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present | Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrate | Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months | Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream |
| SCORE ______ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Riparian Vegetation Zone (EPA, 1999) | Riparian zone extends to a width of >100 feet; all three layers of vegetation exists; good vegetation community diversity and density; human activities do not impact zone | Riparian zone extends to a width of 60 - 100 feet; one layer of vegetation not well represented; fair vegetation community diversity and density; human activities minimally impact zone | Riparian zone extends to a width of 30 - 60 feet; two layers of vegetation not well represented; species composition is dominated by 2 or 3 species; human activities greatly impact zone | Riparian zone extends to a width of <30 feet; little or no riparian vegetation due to human activities |
| | left: 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| 8. Riparian Zone Nutrient Uptake Potential (Chesapeake Bay Program, 1995;EPA, 1999; & Baltimore County, 1991) | All three zones of vegetation exist; runoff is primarily sheet flow; hillslopes < 10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented | One zone of vegetation not well represented (Zone 2 must be well represented); runoff is moderately sheet flow with some concentrated flow; hillslopes 10 - 20%; hillslopes 100 - 200 ft from stream; ponding or wetland areas and litter or debris jams are moderately represented | Only Zone 2 of vegetation is well represented; runoff is equally sheet and concentrated flow (gully and rill erosion occurring); hillslopes 20 - 40%; hillslopes 50 - 100 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented | No zones of vegetation well represented; >runoff is concentrated flow (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent |
| | left: 10 9 | 8 7 6 | 5 4 3 | 2 1 |
| SCORE ______ | right: 10 9 | 8 7 6 | 5 4 3 | 2 1 |

**Riparian/Instream Habitat Total Score ________**

Watershed: ______________________________



Stream: ______________________________ Rater(s): ______________________

Reach ID: ______________________________ Date: ______________________

# RIPARIAN CORRIDOR ASSESSMENT FIELD DATA SHEET

(additional bank stability assessment sheets if bank conditions vary within an assessment area)

Watershed: ______________________ Rater(s): ______________________

Stream: ______________________ Date: ______________________

Reach ID: ______________________

**BANK No.:** ________

| Stream Stability Parameter | | Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Optimal | | Suboptimal | | | Marginal | | | Poor | |
| **Bank Stability** | | | | | | | | | | | |
| 1. Bank Height /Bankfull Height (Rosgen 1996) | | Incision Ratio of 1.0 - 1.19 | | Incision Ratio of 1.2 - 1.5 | | | Incision Ratio of 1.6 - 2.0 | | | Incision Ratio of > 2.1 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 2. Root Depth/Bank Height Ratio (Rosgen 1996) | | Ratio of 1.0 - 0.50 | | Ratio of 0.49 - 0.3 | | | Ratio of 0.29 - 0.15 | | | Ratio of < 0.14 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 3. Root Density % (Rosgen 1996) | | 100% - 55% | | 54% - 30% | | | 29% - 15% | | | <14% | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 4. Bank Angle (degrees) (Rosgen 1996) | | 0 - 60 | | 61 - 80 | | | 81 - 90 | | | >90 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 5. Surface Protection % (Rosgen 1996) | | 100% - 55% | | 54% - 30% | | | 29% - 15% | | | <14% | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| **Streambank Stability Score** ________ | | | | | | | | | | | |

**BANK No.:** ________

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bank Height /Bankfull Height (Rosgen 1996) | | Incision Ratio of 1.0 - 1.19 | | Incision Ratio of 1.2 - 1.5 | | | Incision Ratio of 1.6 - 2.0 | | | Incision Ratio of > 2.1 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 2. Root Depth/Bank Height Ratio (Rosgen 1996) | | Ratio of 1.0 - 0.50 | | Ratio of 0.49 - 0.3 | | | Ratio of 0.29 - 0.15 | | | Ratio of < 0.14 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 3. Root Density % (Rosgen 1996) | | 100% - 55% | | 54% - 30% | | | 29% - 15% | | | <14% | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 4. Bank Angle (degrees) (Rosgen 1996) | | 0 - 60 | | 61 - 80 | | | 81 - 90 | | | >90 | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| 5. Surface Protection % (Rosgen 1996) | | 100% - 55% | | 54% - 30% | | | 29% - 15% | | | <14% | |
| | left: | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| SCORE ______ | right: | 10 | 9 | 9 | 7 | 6 | 6 | 4 | 3 | 3 | 1 |
| **Streambank Stability Score** ________ | | | | | | | | | | | |

# APPENDIX B

# ADDITIONAL RELATED REFERERENCES

## ADDITIONAL RELATED REFERENCES

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